

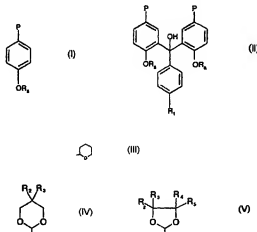
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(54) **Title:** INTERMEDIATE COMPOUNDS USEFUL FOR MAKING ANTIVIRAL COMPOUNDS

(57) **Abstract:** Novel compounds of Formula I and Formula II (below): formula (I) wherein R<sub>1</sub> is selected from the group consisting of -CH<sub>2</sub>-OCH<sub>3</sub>, -CH<sub>2</sub>-OCH<sub>2</sub>CH<sub>3</sub>, -CH(CH<sub>3</sub>)OCH<sub>2</sub>CH<sub>3</sub>, -CH<sub>2</sub>-OCH<sub>2</sub>CH<sub>2</sub>-OCH<sub>3</sub>, -CH<sub>2</sub>OCH<sub>2</sub>CH<sub>2</sub>-Si(CH<sub>3</sub>)<sub>3</sub>, and formula (II); R<sub>2</sub> is a radical selected from the group consisting of hydrogen, halogen, perfluoroalkyl, nitro, carbalkoxy, carboxamide, carboxamidalkyl, alkyl, cycloalkyl, alkoxy, alkoxyalkyl, alkoxy-C<sub>2</sub>-C<sub>6</sub>-alkoxy, alkylsulfinyl, alkylsulfonyl, sulfonamide, cyano, amido, dialkylamino, OR<sub>1</sub>, or a heterocyclic radical selected from the group consisting of morpholinyl, piperidinyl, pyrrolidinyl, or an N-substituted piperazinyl, said piperazinyl substituents selected from an alkyl group, the point of attachment of said heterocyclic radical is at a nitrogen atom; P is a protected formaldehyde group such as: formula (III) or formula (IV) wherein R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub> and R<sub>5</sub> are independently selected from the group consisting of hydrogen or alkyl. The compounds are useful for making antiviral agents.



— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

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## INTERMEDIATE COMPOUNDS USEFUL FOR MAKING ANTIVIRAL COMPOUNDS

### FIELD OF THE INVENTION

The present invention relates to novel intermediate compounds which are useful for preparing antiviral compounds. The invention also relates to the methods of making the intermediate compounds and methods of preparing antiviral compounds from the intermediate compounds.

### BACKGROUND OF THE INVENTION

The *Pneumovirinae* subfamily of the *Paramyxoviridae* family consists of pneumoviruses that cause significant disease in humans and a number of animal species including cattle, goats, sheep, and mice, and in avian species.

Human respiratory syncytial virus (RSV), the prototypic member of the pneumovirus group, is the major pediatric viral respiratory tract pathogen, causing pneumonia and bronchiolitis in infants and young children. RSV disease is seasonal, with outbreaks in the U.S. typically beginning in November and continuing through April. During these yearly epidemics, approximately 250,000 infants contract RSV pneumonia, and up to 35% are hospitalized. Of those hospitalized, mortality rates of up to 5% have been reported. Children with underlying conditions such as prematurity, congenital heart disease, bronchopulmonary dysplasia and various congenital or acquired immunodeficiency syndromes are at greatest risk of serious RSV morbidity and mortality. In adults, RSV usually causes upper respiratory tract manifestations but can also cause lower respiratory tract disease, especially in the elderly and in immunocompromised persons. Infection in elderly and immunocompromised persons can be associated with high death rates. Natural infection with RSV fails to provide full protective immunity. Consequently, RSV causes repeated symptomatic infections throughout life.

The pneumoviruses of animals and avian species are similar to the human virus antigenically, in polypeptide composition and in disease causation.

Attempts to develop vaccines for RSV are ongoing, but none have yet been demonstrated to be safe and efficacious. Vaccine development has been shadowed by adverse reactions exhibited by the initial formalin-inactivated RSV vaccine introduced in the late 1960s. Immunized children showed an increased incidence of RSV lower respiratory tract disease and developed abnormally severe illnesses, including death.

Chemotherapy with ribavirin [1-beta-D-ribofuranosyl-1H-1,2,4-triazole-3-carboxamide], an antiviral nucleoside which is the only pharmaceutical approved by the U.S. Food and Drug Administration (FDA) for treatment of RSV disease, is considered only for certain RSV patients (e.g., those at high risk for severe complications or who are seriously ill with this infection). However, its efficacy and value are controversial. Recent studies have reported a failure to demonstrate either clinical or economic benefit to patients on ribavirin treatment. Moreover, ribavirin has certain toxic side-effects and, in order to minimize these, must be administered by inhalation as an aerosol in an enclosed environment.

A human intravenous immune globulin (IVIG) preparation is licensed for prophylactic use in certain patients at high-risk for RSV disease. Administration of this drug requires intravenous infusion of a large volume over a 2 to 4 hour period in children who have limited venous access due to prior intensive therapy, as well as compromised cardiopulmonary function. Moreover, intravenous infusion necessitates monthly hospital visits during the RSV season, which in turn places children at risk of nosocomial infections.

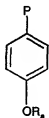
Thus, a need exists for new anti-viral agents and treatments for RSV infection that overcome the shortcomings of existing pharmaceutical preparations.

International Patent Application No. PCT/US99/01985 (filed on January 29, 1999), now published as WO 99/38508, teaches certain dialdehyde compounds to be useful as an intermediate for making certain useful antiviral compounds, and is hereby expressly incorporated-by-reference in its entirety.

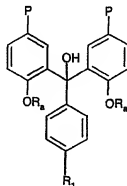
**SUMMARY OF THE INVENTION**

It has now unexpectedly been discovered that various 4,4'-dihydroxy-3,3'-(4-substituted-phenyl)methylenebisbenzaldehydes, which are useful intermediates for the preparation of compounds exhibiting antiviral activity against RSV, can be made advantageously by novel methods from novel precursor compounds.

The aforementioned intermediates can be made from compounds of Formula I and Formula II (below):



(I)



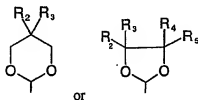
(II)

wherein  $R_a$  is selected from the group consisting of  $-\text{CH}_2-\text{OCH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}(\text{CH}_3)\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_2-\text{OCH}_3$ ,  $-\text{CH}_2\text{OCH}_2\text{CH}_2-\text{Si}(\text{CH}_3)_3$ , and



$R_1$  is a radical selected from the group consisting of hydrogen, halogen, perfluoroalkyl, nitro, carbalkoxy, carboxamide, carboxamidoalkyl, alkyl, cycloalkyl, alkoxy, alkoxyalkyl, alkoxy- $\text{C}_2\text{-C}_6$ -alkoxy, alkylsulfinyl, alkylsulfonyl, sulfonamide, cyano, amido, dialkylamino,  $\text{OR}_a$ , or a heterocyclic radical selected from the group consisting of morpholinyl, piperidinyl, pyrrolidinyl, or an N-substituted piperazinyl, said piperazinyl substituents selected from an alkyl group, the point of attachment of said heterocyclic radical is at a nitrogen atom;

P is a protected formaldehyde group such as:

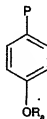


wherein  $R_2$ ,  $R_3$ ,  $R_4$  and  $R_5$  are independently selected from the group consisting of hydrogen or alkyl.

The invention also relates to methods of making the compounds of Formula I and Formula II and methods of using such compounds in the preparation of antiviral compounds.

#### DETAILED DESCRIPTION OF THE INVENTION

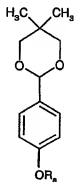
In one aspect, the instant invention provides the compound of Formula I:



(I)

wherein P and  $R_a$  are as defined above.

A preferred aspect of the invention includes the compound of Formula Ia having the formula:

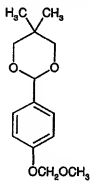


(Ia)

wherein R<sub>a</sub> is as defined above.

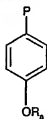
Another preferred aspect of the invention involves the compound of Formula I wherein R<sub>a</sub> is -CH<sub>2</sub>-OCH<sub>3</sub>.

An ultimately preferred compound of the invention is that having the formula:



Preferred compounds include compounds of Table 1:







TABLE I



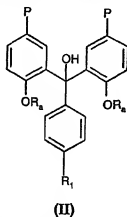
(I)

Compound Number	P	R <sub>a</sub>
1		-CH <sub>2</sub> -OCH <sub>3</sub>
2		-CH <sub>2</sub> -OCH <sub>2</sub> CH <sub>3</sub>
3		-CH(CH <sub>3</sub> )OCH <sub>2</sub> CH <sub>3</sub>
4		-CH <sub>2</sub> -OCH <sub>2</sub> CH <sub>2</sub> -OCH <sub>3</sub>
5		-CH <sub>2</sub> OCH <sub>2</sub> CH <sub>2</sub> -Si(CH <sub>3</sub> ) <sub>3</sub>
6		
7		-CH <sub>2</sub> -OCH <sub>3</sub>



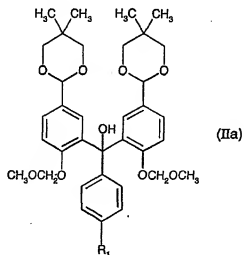
Compound Number	P	R <sub>4</sub>
8		-CH <sub>2</sub> -OCH <sub>2</sub> CH <sub>3</sub>
9		-CH(CH <sub>3</sub> )OCH <sub>2</sub> CH <sub>3</sub>
10		-CH <sub>2</sub> -OCH <sub>2</sub> CH <sub>2</sub> -OCH <sub>3</sub>
11		-CH <sub>2</sub> OCH <sub>2</sub> CH <sub>2</sub> -Si(CH <sub>3</sub> ) <sub>3</sub>
12		

Another aspect of the present invention is the compound of Formula II:



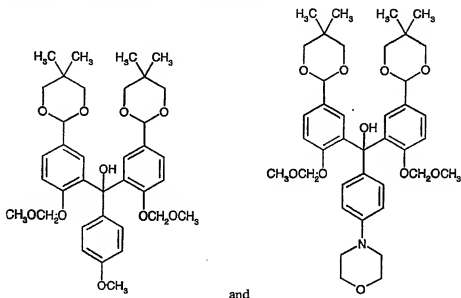
wherein P, R<sub>1</sub>, and R<sub>a</sub> are as defined above.

A preferred aspect of the invention includes the compound of Formula II having the formula:



wherein  $R_1$  is as defined above.

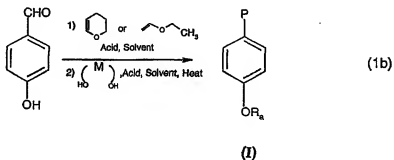
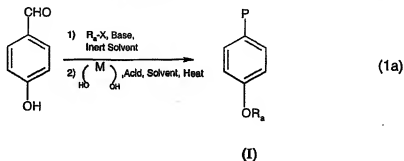
Preferred compounds of Formula II include:



Further aspects of the invention are the methods of preparing the compounds of Formula I and II. The compound of Formula I may be prepared according to the following Schemes:

### SCHEME 1

M =  $(CH_2-CR_2R_3-CH_2)$  or  $(CR_2R_3-CR_4R_5)$  wherein  $R_2$ ,  $R_3$ ,  $R_4$  and  $R_5$  are defined above; and  $R_a$  is as defined above.




The 4-hydroxybenzaldehyde starting material in Scheme 1 is known and readily available from commercial sources. The order of the protection conditions used for the preparation of the di-protected compound of Formula I may be reversed, and the single-protected intermediates prepared therein may be isolated and/or purified if desired prior to preparation of the compound of Formula I.

Scheme (1a) involves the reaction of 4-hydroxybenzaldehyde with an appropriate  $R_a-X$  reagent, wherein X is chloride, bromide, or iodide, in the presence of a base such as

diisopropylethylamine, triethylamine, potassium carbonate, sodium hydride, or pyridine; and in an inert solvent. Depending on the base, a preferable inert solvent may be one or more of the following: dichloromethane, tetrahydrofuran, 1-methyl-2-pyrrolidinone, dimethyl sulfoxide, acetone, or N,N-dimethylformamide; at temperatures ranging from -20°C to 100°C. For example, Scheme (1a) would be amenable to making compounds of Formula I wherein  $R_4$  is  $-\text{CH}_2\text{OCH}_3$ ,  $-\text{CH}_2\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_2-\text{OCH}_3$ , or  $-\text{CH}_2-\text{OCH}_2\text{CH}_2-\text{Si}(\text{CH}_3)_3$ . The aldehyde is protected by refluxing with the appropriate glycol in the presence of an acid, e.g., pyridinium para-toluenesulfonate, pyridinium hydrochloride, *p*-toluenesulfonic acid monohydrate, camphorsulfonic acid, and Amberlyst®-15; and in an inert solvent, such as benzene, toluene, cyclohexane or tetrahydrofuran, preferably with the azeotropic removal of water. The acid is preferably a mild acid and/or preferably used in a catalytic amount.

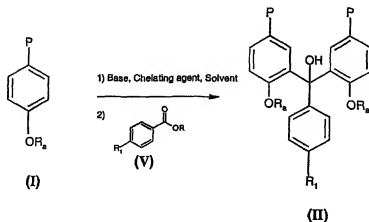
Scheme (1b) involves the reaction of 4-hydroxybenzaldehyde with dihydropyran

in the case where  $R_4$  is  or with ethyl vinyl ether in the case where  $R_4$  is  $-\text{CH}(\text{CH}_3)\text{OCH}_2\text{CH}_3$  in the presence of an acid catalyst, such as pyridinium para-toluenesulfonate, dry hydrochloric acid, pyridinium hydrochloride, camphorsulfonic acid, Amberlyst®-15, or *p*-toluenesulfonic acid monohydrate; and in a non-polar inert solvent, such as methylene chloride, ethyl acetate, dimethoxyethane, dioxane, chloroform, dichloroethane, or tetrahydrofuran; at temperatures between -20°C and 140°C, or otherwise above the freezing point and up to the reflux temperature of the solvent. The aldehyde is protected as above in Scheme (1a).

The compound of Formula II may be prepared according to the following Scheme:

## SCHEME 2

P, R<sub>a</sub> and R<sub>i</sub> are as defined above; R is an alkyl group; and Solvent = aprotic solvent such as tetrahydrofuran.



The compounds of Formula II may be prepared in general by treating the compound of Formula I with one or more known alkali metal bases, such as *n*-butyllithium, *sec*-butyllithium, and *t*-butyllithium, or a metal amide base, such as lithium diisopropylamide; preferably in the presence of a chelating agent, such as *N,N,N',N'*-tetramethylethylenediamine (TMEDA) or hexamethylphosphoramide (HMPA); followed by the addition of an alkyl ester of the appropriate 4-substituted benzoic acid (Formula V) that corresponds to the desired product of Formula II. The reaction may be conducted preferably in the presence of an aprotic organic solvent, such as tetrahydrofuran, 2-methyltetrahydrofuran, diethylether, or *t*-butyl methyl ether, and preferably at reduced temperatures, e.g. between -70°C and room temperature. It is also preferable to conduct the reaction under anhydrous or substantially anhydrous conditions.

The compounds of Formula V may be purchased from commercial sources or alternatively are readily synthesized by standard procedures which are well known to those of ordinary skill in the art.



Preferred compounds of Formula V include compounds of Table 2:

TABLE 2



(V)

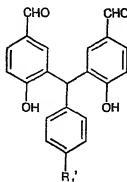
Compound Number	R	R <sub>1</sub>
13	CH <sub>3</sub>	OCH <sub>2</sub> OCH <sub>3</sub>
14	CH <sub>3</sub>	F
15	CH <sub>3</sub>	Cl
16	CH <sub>3</sub>	Br
17	CH <sub>3</sub>	CF <sub>3</sub>
18	CH <sub>3</sub>	CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
19	CH <sub>3</sub>	N(CH <sub>3</sub> ) <sub>2</sub>
20	CH <sub>3</sub>	CH <sub>2</sub> CF <sub>3</sub>
21	CH <sub>3</sub>	CH(CH <sub>3</sub> ) <sub>2</sub>
22	CH <sub>3</sub>	CH <sub>3</sub>
23	CH <sub>3</sub>	OCH <sub>3</sub>
24	CH <sub>3</sub>	OCH <sub>2</sub> CH <sub>3</sub>
25	CH <sub>3</sub>	CH <sub>2</sub> CH(CH <sub>2</sub> CH <sub>3</sub> ) <sub>2</sub>
26	CH <sub>3</sub>	
27	CH <sub>3</sub>	CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
28	CH <sub>3</sub>	CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
29	CH <sub>3</sub>	CH(CH <sub>3</sub> )CH <sub>2</sub> CH <sub>3</sub>
30	CH <sub>3</sub>	CH <sub>2</sub> CH(CH <sub>3</sub> ) <sub>2</sub>
31	CH <sub>3</sub>	CH <sub>2</sub> CH <sub>2</sub> OCH <sub>3</sub>
32	CH <sub>3</sub>	CH <sub>2</sub> CH <sub>3</sub>
33	CH <sub>3</sub>	

Compound Number	R	R <sub>1</sub>
34	CH <sub>3</sub>	NO <sub>2</sub>
35	CH <sub>3</sub>	OCH <sub>2</sub> CH <sub>2</sub> OCH <sub>3</sub>
36	CH <sub>3</sub>	N(CH <sub>2</sub> CH <sub>3</sub> )(CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub> )
37	CH <sub>2</sub> CH <sub>3</sub>	OCH <sub>2</sub> OCH <sub>3</sub>
38	CH <sub>2</sub> CH <sub>3</sub>	F
39	CH <sub>2</sub> CH <sub>3</sub>	Cl
40	CH <sub>2</sub> CH <sub>3</sub>	Br
41	CH <sub>2</sub> CH <sub>3</sub>	CF <sub>3</sub>
42	CH <sub>2</sub> CH <sub>3</sub>	CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
43	CH <sub>2</sub> CH <sub>3</sub>	N(CH <sub>3</sub> ) <sub>2</sub>
44	CH <sub>2</sub> CH <sub>3</sub>	CH <sub>2</sub> CF <sub>3</sub>
45	CH <sub>2</sub> CH <sub>3</sub>	CH(CH <sub>3</sub> ) <sub>2</sub>
46	CH <sub>2</sub> CH <sub>3</sub>	CH <sub>3</sub>
47	CH <sub>2</sub> CH <sub>3</sub>	OCH <sub>3</sub>
48	CH <sub>2</sub> CH <sub>3</sub>	OCH <sub>2</sub> CH <sub>3</sub>
49	CH <sub>2</sub> CH <sub>3</sub>	CH <sub>2</sub> CH(CH <sub>2</sub> CH <sub>3</sub> ) <sub>2</sub>
50	CH <sub>2</sub> CH <sub>3</sub>	
51	CH <sub>2</sub> CH <sub>3</sub>	CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
52	CH <sub>2</sub> CH <sub>3</sub>	CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>
53	CH <sub>2</sub> CH <sub>3</sub>	CH(CH <sub>3</sub> )CH <sub>2</sub> CH <sub>3</sub>
54	CH <sub>2</sub> CH <sub>3</sub>	CH <sub>2</sub> CH(CH <sub>3</sub> ) <sub>2</sub>
55	CH <sub>2</sub> CH <sub>3</sub>	CH <sub>2</sub> CH <sub>2</sub> OCH <sub>3</sub>
56	CH <sub>2</sub> CH <sub>3</sub>	CH <sub>2</sub> CH <sub>3</sub>
57	CH <sub>2</sub> CH <sub>3</sub>	
58	CH <sub>2</sub> CH <sub>3</sub>	NO <sub>2</sub>
59	CH <sub>2</sub> CH <sub>3</sub>	OCH <sub>2</sub> CH <sub>2</sub> OCH <sub>3</sub>
60	CH <sub>2</sub> CH <sub>3</sub>	N(CH <sub>2</sub> CH <sub>3</sub> )(CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub> )
61	CH <sub>2</sub> CH <sub>3</sub>	C(O)-OC(CH <sub>3</sub> ) <sub>3</sub>

Compound Number	R	R <sub>1</sub>
62	CH <sub>2</sub> CH <sub>3</sub>	C(O)-OC <sub>2</sub> H <sub>5</sub>

Preferred compounds of Formula II can be prepared by reacting the compounds of Table 1 with compounds of Table 2 under the reaction conditions of Scheme 2.

Another feature of the invention is the method of preparing the dialdehyde compound of Formula III:



(III)

wherein R<sub>1</sub>' is a radical selected from the group consisting hydrogen, hydroxy, halogen, perfluoroalkyl, nitro, carbalkoxy, carboxamide, carboxamidoalkyl, alkyl, alkoxy, alkoxyalkyl, alkoxy-C<sub>2</sub>-C<sub>6</sub>-alkoxy, cycloalkyl, alkylsulfinyl, alkylsulfonyl, sulfonamide, cyano, amido, dialkylamino, or a heterocyclic radical selected from the group consisting of morpholinyl, piperadinyl, pyrrolidinyl, or an N-substituted piperazinyl, said piperazinyl substituents selected from an alkyl group, the point of attachment of said heterocyclic radical is at a nitrogen atom.

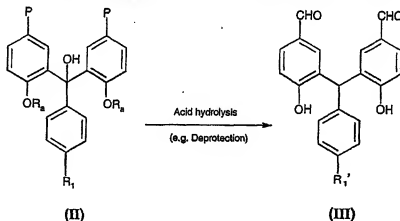
The compounds of Formula III are useful for preparing antiviral compounds described in International Patent Application No. PCT/US99/01985 (filed on January 29, 1999), now published as WO 99/38508.



The compound of Formula III may be prepared according to the following Scheme 3 below.

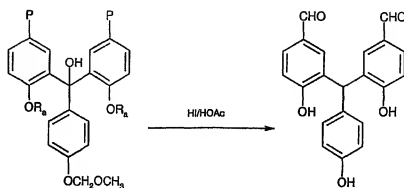
### SCHEME 3

Acid Hydrolysis = treatment with deprotection conditions such as hydriodic acid (HI) and acetic acid (HOAc); and  $R_1$ ,  $R_1'$ , P and  $R_1'$  are as defined above.



Reduction and regeneration of the aldehyde is achieved under certain acidic conditions, such as hydriodic acid in acetic acid, preferably at room temperature; to form the dialdehyde intermediate of Formula III. The compounds of Formula III are not co-extensive with compounds of Formula II because the compounds of Formula II where  $R_1$  is  $OR_a$  will not survive the reaction conditions and will undergo deprotection to form  $R_1'$ .

A preferred aspect of the invention is the process of preparing the compound of Formula III, wherein  $R_1'$  is  $-OH$  from compounds of Formula II wherein  $R_1$  is an  $OR_a$  group, by treating compounds of Formula II with hydriodic acid in acetic acid, preferably at room temperature:

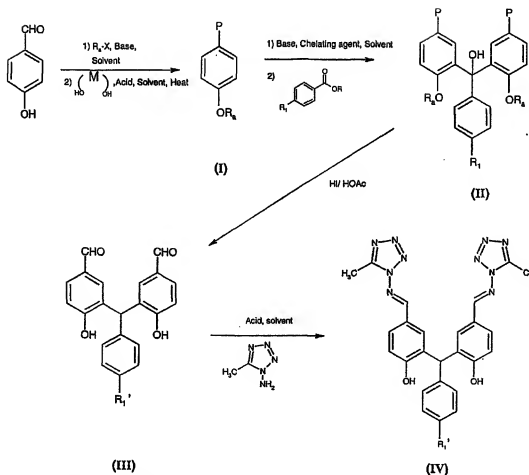


A feature of the instant invention includes the methods of making certain antiviral compounds disclosed in International Patent Application No. PCT/US99/01985 from the compounds of Formula I and/or II using the corresponding methods of making disclosed herein.

Scheme 4 illustrates an aspect of the invention regarding a method of preparing the antiviral compound of Formula IV:

#### SCHEME 4

HI = hydriodic acid; HOAc = acetic acid; and P, M, R<sub>1</sub>, R<sub>1</sub>', R<sub>2</sub>, and R<sub>3</sub> are as defined above.



The last step involves the condensation of the aldehyde groups with 5-methyl-1H-tetrazolamine, in the presence of an acid, such as *p*-toluenesulfonic acid monohydrate, methanesulfonic acid, benzenesulfonic acid, or pyridinium *para*-toluenesulfonate, at elevated temperatures, e.g. from room temperature to 90°C; in a solvent such as an alcoholic solvent like ethanol, or in 1-methyl-2-pyrrolidinone, dimethyl sulfoxide, or *N,N*-dimethylformamide; to provide the antiviral compound of Formula IV. The compounds of Formula IV are useful for treating and preventing disease caused by *Pneumovirinae* viruses, preferably human respiratory syncytial virus (RSV).

The term "alkyl", as used herein, refers to aliphatic hydrocarbon radicals of one to six carbon atoms in length. Similarly, the term "alkyl", or any variation thereof, used in combination form to name substituents, such as alkoxy (-O-alkyl), alkylthio (-S-alkyl), alkylamino (-NH-alkyl), alkylsulfinyl (-S(O)-alkyl), alkylsulfonyl (-S(O)<sub>2</sub>-alkyl),

carboxamidoalkyl (-alkyl-C(=O)-NR"R'''), or the like, also refers to aliphatic hydrocarbon radicals of one to six carbon atoms in length, and preferably of one to four carbon atoms in length.

The term "amido", as used herein, refers to a radical or substituent of the formula -NR"C(=O)R''', wherein R" and R''' represent alkyl.

The term "carboxamide", as used herein, refers to a radical or substituent of the formula -C(=O)-NR"R''', wherein R" and R''' are as previously defined.

The term "sulfonamide", as used herein, refers to a radical or substituent of the formula -SO<sub>2</sub>NR"R''' or -NR"SO<sub>2</sub>R''', wherein R" and R''' are as previously defined.

The term "carbalkoxy", as used herein, refers to a radical or substituent -C(=O)-OR", wherein R" is a previously defined.

The following examples are provided to describe the invention in further detail. These examples, which set forth the preferred mode presently contemplated for carrying out the invention, are intended to illustrate and not to limit the invention.

Examples 1-5 illustrate suitable methods of synthesis of representative compounds of this invention. However, the methods of synthesis are not limited to those exemplified below.

#### EXAMPLE 1

##### **2-(4-Methoxymethoxyphenyl)-5,5-dimethyl-1,3-dioxane**

(a) 4-Methoxymethoxybenzaldehyde: 4-Hydroxybenzaldehyde (10.04 g, 87.2 mmol) was dissolved in 160 ml of methylene chloride and 28.0 ml of N,N-diisopropylethylamine, under argon. The solution was cooled to 0 °C, and chloromethyl methyl ether (8.1 ml, 107 mmol) was added. After the addition, the solution was warmed to room temperature, and then stirred for 2 hours. The reaction was quenched with water, and the aqueous phase was separated from the organic phase. The aqueous phase was further extracted two times with methylene chloride, and the combined organic layers were washed with saturated aqueous NaCl. The solution was dried with sodium sulfate, filtered, and rotary evaporated. The product was taken directly to next step.

(b) 2-(4-Methoxymethoxyphenyl)-5,5-dimethyl-1,3-dioxane:

4-Methoxymethoxybenzaldehyde from step (a) above, neopentyl glycol (10.3 g, 98.9 mmol), and pyridinium para-toluenesulfonate (1.0 g, 3.98 mmol) were dissolved in 500 ml of benzene. The flask was equipped with a Dean-Stark trap, and the reaction was heated to reflux for several hours, under argon with azeotropic removal of water. The reaction was cooled to room temperature, quenched with 2 ml of triethylamine, and concentrated on rotary evaporator. The product was chromatographed on silica with a gradient of 5% ethyl acetate in hexanes, yielding 10.95 g of clean product.

#### **EXAMPLE 2**

##### **5,5'-Bis (5,5-dimethyl-1,3-dioxan-2-yl)-4''-methoxy-2,2'-bis(methoxymethoxy)triphenylmethanol**

2-(4-Methoxymethoxyphenyl)-5,5-dimethyl-1,3-dioxane (5.02 g, 19.9 mmol) was dissolved in 65 ml of distilled tetrahydrofuran in a 3-neck flask, under argon. N,N,N',N'-Tetramethylethylenediamine (3.0 ml, 19.9 mmol) was added to the solution, and the resulting mixture was stirred at 0 °C in an ice/NaCl bath. Sec-butyllithium (16.8 ml, 1.3 M in cyclohexane) was added via a syringe pump at the rate of 0.25ml/min, maintaining the reaction at a constant temperature. The solution was stirred for 15 minutes, then a second solution of methyl 4-methoxybenzoate (1.10 g, 6.62 mmol) in 25 ml distilled tetrahydrofuran was added drop wise to the reaction. After this addition, the solution was stirred for 2 hours at 0 °C. The reaction was then quenched with half-saturated aqueous NH<sub>4</sub>Cl solution. The organic solvents were removed *in vacuo*, and the aqueous mixture was extracted three times with ethyl acetate. The organic layers were combined, washed with saturated aqueous NaCl, dried with sodium sulfate, filtered, and concentrated on rotary evaporator. The residue was chromatographed on silica with a gradient of 20-30 % ethyl acetate in hexanes, yielding 3.55 g of desired product as a solid, white foam.

#### **EXAMPLE 3**

##### **4,4'-dihydroxy-3,3'-(4-methoxyphenyl)methylenebisbenzaldehyde**

5,5'-Bis (5,5-dimethyl-1,3-dioxan-2-yl)-4''-methoxy-2,2'-bis(methoxymethoxy)triphenylmethanol (0.998 g, 1.56 mmol) was dissolved in 16 ml of glacial acetic acid. Hydriodic acid (2.6 ml, 57 wt % in water) was added in one portion, turning the solution brown. The reaction was stirred at room temperature overnight, under argon.

The reaction mixture was diluted with 200 ml of water and extracted three times with ethyl acetate. The organic layers were combined and washed with saturated aqueous NaHSO<sub>3</sub> (200 ml). The solution was dried over sodium sulfate, rotary evaporated, and further dried under vacuum. The resulting brown solid was heated and sonicated in 50 ml of ethyl acetate, then cooled to room temperature. The remaining solid was collected by filtration, rinsed with ethyl acetate, and dried under vacuum, yielding 321.1 mg of product.

#### EXAMPLE 4

$\alpha,\alpha$ -Bis-[5-(5,5-dimethyl-1,3-dioxan-2-yl)-2-(methoxymethoxy)phenyl]- $\alpha$ -[4-(4-morpholinyl)phenyl]methanol

(a) 4-(4-Morpholinyl)benzoic acid ethyl ester: A Schenk flask containing ethyl 4-bromobenzoate (3.39 g, 14.8 mmol), tris(dibenzylideneacetone)dipalladium(0) (0.136 g, 0.148 mmol), (S)-binaphthol (0.138 g, 0.222 mmol), and cesium carbonate (6.79 g, 20.8 mmol) was evacuated by vacuum and filled with argon. Morpholine (1.55 g, 17.8 mmol, distilled from KOH) and toluene (50 ml) were added to the flask. The reaction vessel was then closed and heated to 100 °C for 24 hours. The reaction mixture was cooled to room temperature, diluted with water, and extracted with ether (3x). The mixture was washed with brine, dried (MgSO<sub>4</sub>), filtered, and concentrated *in vacuo*. The crude product was purified via column chromatography (silica gel, 50 % ethyl acetate in hexanes) to provide 0.67 g product.

(b)  $\alpha,\alpha$ -Bis-[5-(5,5-dimethyl-1,3-dioxan-2-yl)-2-(methoxymethoxy)phenyl]- $\alpha$ -[4-(4-morpholinyl)phenyl]methanol: 2-(4-Methoxymethoxyphenyl)-5,5-dimethyl-1,3-dioxane, prepared according to Example 1-b, above (2.05 g, 8.14 mmol) was mixed with N,N,N',N'-tetramethylethylenediamine (0.95 g, 8.14 mmol) and tetrahydrofuran (27 ml).

The mixture was cooled to 0°C in a NaCl/ice mixture bath. Sec-butyllithium (6.9 ml of 1.3 M in cyclohexane, 8.95 mmol) was added dropwise, maintaining the reaction temperature below 0°C. After stirring for 15 minutes, 4-(4-morpholinyl)benzoic acid ethyl ester, prepared in step a, above (0.60 g, 2.55 mmol) dissolved in tetrahydrofuran (15 ml) was added dropwise to the reaction mixture. The reaction was slowly warmed to room temperature and stirred overnight. The reaction was quenched with 10% NH<sub>4</sub>Cl solution, and the tetrahydrofuran was removed on rotary evaporator. The remaining solution was diluted with water and extracted with ethyl acetate. The organic layer was washed with brine, dried (MgSO<sub>4</sub>), filtered, and concentrated *in vacuo*, to provide 0.63 g of desired product.

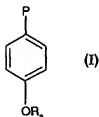
#### EXAMPLE 5

##### 3,3'-[[4-(4-morpholinyl)phenyl]methylene]bis-4-hydroxybenzaldehyde

Hydriodic acid (0.58 ml, 58 wt % in water) was added to a solution of  $\alpha,\alpha$ -Bis-[5-(5,5-dimethyl-1,3-dioxan-2-yl)-2-(methoxymethoxy)phenyl]- $\alpha$ -[4-(4-morpholinyl)phenyl]methanol prepared according to Example 4, (0.40 g, 0.58 mmol) in glacial acetic acid (5.8 ml). The reaction was stirred at room temperature for 2 hours. The reaction mixture was poured over ice/water, and 10% aqueous NaHSO<sub>3</sub> was added. The mixture was extracted with ethyl acetate, and the organic layer was washed with 10% aqueous NaHSO<sub>3</sub> and saturated aqueous NaCl solution. The organics were dried over magnesium sulfate, filtered, and rotary evaporated. The resulting solid was recrystallized in ethyl acetate/hexanes, than further purified via column chromatography (silica gel, ethyl acetate/hexanes) to provide 38.7 mg of desired product.

## WHAT IS CLAIMED IS:

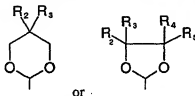
1. A compound having the formula:



wherein  $R_a$  is selected from the group consisting of  $-\text{CH}_2-\text{OCH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}(\text{CH}_3)\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_2-\text{OCH}_3$ ,  $-\text{CH}_2\text{OCH}_2\text{CH}_2-\text{Si}(\text{CH}_3)_3$ , and

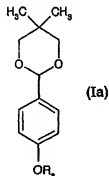


and P is a protected formaldehyde group selected from the group of:



wherein  $R_2$ ,  $R_3$ ,  $R_4$  and  $R_5$  are independently selected from the group consisting of hydrogen or alkyl.

2. A compound according to claim 1 wherein  $R_a$  is  $-\text{CH}_2-\text{OCH}_3$ .
3. A compound according to claim 1 having the formula:

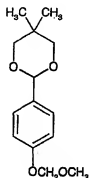




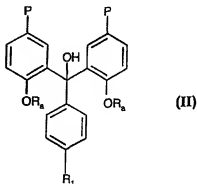
wherein  $R_a$  is selected from the group consisting of  $-\text{CH}_2-\text{OCH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}(\text{CH}_3)\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_2-\text{OCH}_3$ ,  $-\text{CH}_2\text{OCH}_2\text{CH}_2-\text{Si}(\text{CH}_3)_3$ , and



4. The compound according to claim 1 having the formula:



5. A compound having the formula:



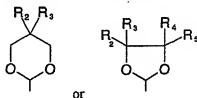
wherein  $R_a$  is selected from the group consisting of  $-\text{CH}_2-\text{OCH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}(\text{CH}_3)\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_2-\text{OCH}_3$ ,  $-\text{CH}_2\text{OCH}_2\text{CH}_2-\text{Si}(\text{CH}_3)_3$ , and



$R_1$  is a radical selected from the group consisting of hydrogen, halogen, perfluoroalkyl, nitro, carbalkoxy, carboxamide, carboxamidoalkyl, alkyl, cycloalkyl,

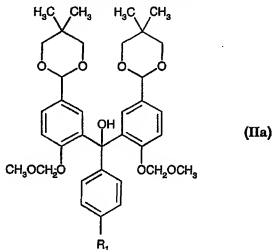
alkoxy, alkoxyalkyl, alkoxy-C<sub>2</sub>-C<sub>6</sub>-alkoxy, alkylsulfinyl, alkylsulfonyl, sulfonamide, cyano, amido, dialkylamino, OR<sub>a</sub>, or a heterocyclic radical selected from the group consisting of morpholinyl, piperadinyl, pyrrolidinyl, or an N-substituted piperazinyl, said piperazinyl substituents selected from an alkyl group, the point of attachment of said heterocyclic radical is at a nitrogen atom.

P is a protected formaldehyde group selected from the group of:



wherein R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub> and R<sub>5</sub> are independently selected from the group consisting of hydrogen or alkyl.

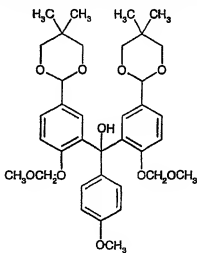
6. A compound according to claim 5 having the formula:



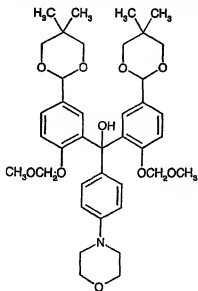
wherein R<sub>1</sub> is a radical selected from the group consisting of hydrogen, halogen, perfluoroalkyl, nitro, carbalkoxy, carboxamide, carboxamidoalkyl, alkyl, cycloalkyl, alkoxy, alkoxyalkyl, alkoxy-C<sub>2</sub>-C<sub>6</sub>-alkoxy, alkylsulfinyl, alkylsulfonyl, sulfonamide, cyano, amido, dialkylamino, OR<sub>a</sub>, or a heterocyclic radical selected from the group

consisting of morpholinyl, piperadinyl, pyrrolidinyl, or an N-substituted piperazinyl, said piperazinyl substituents selected from an alkyl group, the point of attachment of said heterocyclic radical is at a nitrogen atom.

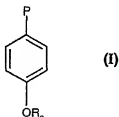
7. The compound according to claim 5 having the formula:



8. The compound according to claim 5 having the formula:



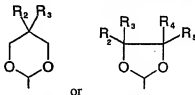
9. The process of preparing the compound having the formula:



wherein  $R_4$  is selected from the group consisting of  $-\text{CH}_2-\text{OCH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}(\text{CH}_3)\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_2-\text{OCH}_3$ ,  $-\text{CH}_2\text{OCH}_2\text{CH}_2-\text{Si}(\text{CH}_3)_3$ , and



and P is a protected formaldehyde group selected from the group of:



wherein  $R_2$ ,  $R_3$ ,  $R_4$  and  $R_5$  are independently selected from the group consisting of hydrogen or alkyl, said process comprising the process steps of:

a) protecting the hydroxy group of the 4-hydroxybenzaldehyde by:

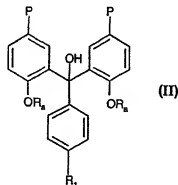
- i) treating 4-hydroxybenzaldehyde with  $R_4-X$  in the presence of a base in an inert solvent, wherein X is chloride, bromide, or iodide; and wherein  $R_4$  is  $-\text{CH}_2\text{OCH}_3$ ,  $-\text{CH}_2\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_2-\text{OCH}_3$ , or  $-\text{CH}_2-\text{OCH}_2\text{CH}_2-\text{Si}(\text{CH}_3)_3$ ; or
- ii) reacting 4-hydroxybenzaldehyde with dihydropyran in the case where  $R_4$  is



or with ethyl vinyl ether in the case where  $R_4$  is  $-\text{CH}(\text{CH}_3)\text{OCH}_2\text{CH}_3$ , in a non-polar inert solvent, in the presence of an acid; and

- b) protecting the aldehyde by refluxing the product of step a) with  $(\overset{\text{M}}{\text{C}})_n$ , wherein M is  $(\text{CH}_2-\text{CR}_2\text{R}_3-\text{CH}_2)$  or  $(\text{CR}_2\text{R}_3-\text{CR}_4\text{R}_5)$ , wherein  $\text{R}_2$ ,  $\text{R}_3$ ,  $\text{R}_4$  and  $\text{R}_5$  are as defined above; in the presence of an acid, and in an inert solvent.

10. The process of preparing the compound having the formula:

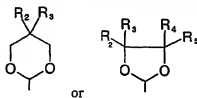


wherein  $\text{R}_a$  is selected from the group consisting of  $-\text{CH}_2-\text{OCH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}(\text{CH}_3)\text{OCH}_2\text{CH}_3$ ,  $-\text{CH}_2-\text{OCH}_2\text{CH}_2-\text{OCH}_3$ ,  $-\text{CH}_2\text{OCH}_2\text{CH}_2-\text{Si}(\text{CH}_3)_3$ , and



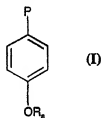
$\text{R}_1$  is a radical selected from the group consisting of hydrogen, halogen, perfluoroalkyl, nitro, carbalkoxy, carboxamide, carboxamidoalkyl, alkyl, cycloalkyl, alkoxy, alkoxyalkyl, alkoxy- $\text{C}_2-\text{C}_6$ -alkoxy, alkylsulfinyl, alkylsulfonyl, sulfonamide, cyano, amido, dialkylamino,  $\text{OR}_a$ , or a heterocyclic radical selected from the group consisting of morpholinyl, piperadinyl, pyrrolidinyl, or an N-substituted piperazinyl, said piperazinyl substituents selected from an alkyl group, the point of attachment of said heterocyclic radical is at a nitrogen atom;

P is a protected formaldehyde group selected from the group of:




wherein  $R_2$ ,  $R_3$ ,  $R_4$  and  $R_5$  are independently selected from the group consisting of hydrogen or alkyl,

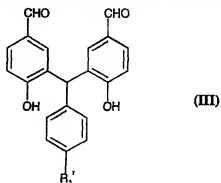
said process comprising the step of treating a compound of Formula I:



with an alkali metal base or a metal amide base, and with an alkyl ester of a substituted

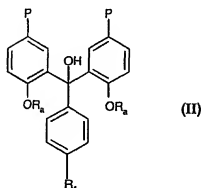
benzoic acid having the formula  wherein R is alkyl.

11. The process of preparing the compound having the formula:



wherein  $R_1$  is a radical selected from the group consisting hydrogen, hydroxy, halogen, perfluoroalkyl, nitro, carbalkoxy, carboxamide, carboxamidoalkyl, alkyl, alkoxy, alkoxyalkyl, alkoxy-C<sub>2</sub>-C<sub>6</sub>-alkoxy, cycloalkyl, alkylsulfinyl, alkylsulfonyl, sulfonamide, cyano, amido, dialkylamino, or a heterocyclic radical selected from the group consisting of morpholinyl, piperidinyl, pyrrolidinyl, or an N-substituted piperazinyl, said piperazinyl substituents selected from an alkyl group, the point of attachment of said heterocyclic radical is at a nitrogen atom;

said process comprising the step of treating a compound of Formula II:



wherein  $R_1$  is a radical selected from the group consisting of hydrogen, halogen, perfluoroalkyl, nitro, carbalkoxy, carboxamide, carboxamidoalkyl, alkyl, cycloalkyl, alkoxy, alkoxyalkyl, alkoxy-C<sub>2</sub>-C<sub>6</sub>-alkoxy, alkylsulfinyl, alkylsulfonyl, sulfonamide, cyano, amido, dialkylamino, OR<sub>a</sub>, or a heterocyclic radical selected from the group consisting of morpholinyl, piperadinyl, pyrrolidinyl, or an N-substituted piperazinyl, said piperazinyl substituents selected from an alkyl group, the point of attachment of said heterocyclic radical is at a nitrogen atom; with hydriodic acid in acetic acid.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/02338

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(7) : C07F 7/02; C07D 317/00, 319/06, 407/00, 413/00; C07C 45/00, 47/56 US CL : 549/214, 370, 374, 414, 453; 544/148; 568/435, 442 According to International Patent Classification (IPC) or to both national classification and IPC														
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) U.S. : 549/214, 370, 374, 414, 453; 544/148; 568/435, 442 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CAS ONLINE														
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <table border="1"> <thead> <tr> <th>Category *</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>EP 319947 A2 (GREEN CROSS CORP.) 14 June 1989 page 2 lines 30-52.</td> <td>1,2</td> </tr> </tbody> </table>			Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	EP 319947 A2 (GREEN CROSS CORP.) 14 June 1989 page 2 lines 30-52.	1,2						
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.												
X	EP 319947 A2 (GREEN CROSS CORP.) 14 June 1989 page 2 lines 30-52.	1,2												
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.														
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Date of the actual completion of the international search 30 April 2002 (30.04.2002)		Date of mailing of the international search report 05 JUN 2002												
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230		Authorized officer <i>Valerie Bell-Harris for</i> Amelia A. Owens Telephone No. 703-308-1235												